



## Tilt Transducer - Type TT420

### User Manual

Issue 1.0



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# 1 Features

- Rugged stainless steel housing suitable for machine mounting in harsh environments (e.g. mining)
- Solid-state, no moving parts for high reliability
- +/- 90deg range
- 4-20mA signal outputs (16-bit DAC) with HART (future option)
- RS485 communications - Modbus RTU
- Operating Temperature: -40°C to +70°C
- Hardware Low Pass Filter (LPF) on sensor signals
- 16-bit ADC with 64x oversampling and software digital filtering algorithms
- Intrinsically Safe 'ia' Group I Mining M1 and Group IIB ATEX and IECEx Certified.

# 2 Description

The unit is constructed from high quality stainless steel and is fully encapsulated providing a rugged solution for all angular and tilt measurements.

The connections are made by a multi-pin plug and socket arrangement on the end of the unit. This allows easy replacement for example if the unit is due for re-calibration.

## 2.1 4-20mA Signal Outputs

The two 4-20mA analogue output signals provide the user with signals corresponding to the pitch and roll of the unit. The first output is HART capable (future software upgrade required), this will allow all the information presented on the RS485 port to be also available to a suitably connected HART interface.

The factory default range supplied is +/- 90°, this corresponds to the 4-20mA levels as shown below –

4mA	=	- 90°
12mA	=	0°
20mA	=	+ 90°

The transducer will drive full scale 20mA into a load resistance of approx. 330R maximum. Typically the load would be 100R or 250R in many applications.

If the transducer detects that it is unable to drive the correct current into the load – for example the loop resistance is greater than 330R or the 12V supply voltage is too low, then it reacts by alternating the 4-20mA output between 0mA and the intended level at 1second intervals. This is to alert the monitoring equipment that the level it is reading is not correct and avoids undetected inaccuracies.

Once the loop resistance/supply voltage returns to within range then the signal returns to the normal correct steady value.

## 2.2 RS485 Communications Port

The RS485 port provides an alternative or in addition to the 4-20mA signals. More information is available using this method, e.g.- scaled angular readings and diagnostic status bits. Some of the information is only used during factory calibration so will not all be useful to the end user.

**Note: The user should not attempt to write to any registers, these are for factory calibration only. They are locked to prevent unintentional writes.**

The Modbus register mapping is shown below -

TT420 MODBUS Communications map REV 2			
Input Registers Read	Status Meanings (bits)	Holding Registers Read/Write	
30001 TT420 Heartbeat	bit 0 Config Valid	40001 DAC 1 Output if enabled	4000-20000 = 4-20mA
30002 Status	bit 1 Pitch Config Valid	40002 DAC 2 Output if enabled	4000-20000 = 4-20mA
30003 Anlg 1 Reading (Voltage) f	bit 2 Roll Config Valid		
30005 Anlg 2 Reading (Voltage) f	bit 3 Pitch invalid	40050 Unlock Code 1	A55A
30007 Anlg 3 Reading (Voltage) f	bit 4 Roll invalid	40051 Unlock Code 2	5AA5
30009 Anlg 4 Reading (Voltage) f	bit 5 DAC 1 Fault	40052 Unlock Code 3	DDDD
30011 Anlg 5 Reading (Voltage) f	bit 6 DAC 2 Fault	40053 TT420 Mode	0 Normal, 1 Config, 255 Reset to Bootloader
30013 Anlg 6 Reading (Voltage) f	bit 7 DACs Not Calibrated		
30015 Anlg 1 Engineering Reading g f	bit 8	40100 Unlock Code 1	A55A
30017 Anlg 2 Engineering Reading g f	bit 9	40101 Unlock Code 2	5AA5
30019 Anlg 3 Engineering Reading g f	bit 10	40102 Unlock Code 3	CCCC
30021 Anlg 4 Engineering Reading V f	bit 11	40103 Serial Number Year	
30023 Anlg 5 Engineering Reading °C f	bit 12	40104 Serial Number	
30025 Anlg 6 Engineering Reading V f	bit 13	40105 Hardware Version	
30027 Pitch (F/B) f	bit 14	40106 Modbus Address	1-254
30029 Roll (L/R) f	bit 15 DAC Calibration mode	40107 Modbus Baudrate	0 115k2, 1 57k6, 2 38k4, 3 19k2, 4 9k6, 5 4k8
30031 DAC Output 1 16bit = 0-20mA		40108 Pitch Range Min	
30032 DAC Output 2 16bit = 0-20mA	f Modbus Float	40109 Pitch Range Max	
30033 Pitch (F/B) x 100		40110 Roll Range Min	
30034 Roll (L/R) x 100		40111 Roll Range Max	
30035 Serial Number Year		40112 DAC 1 Sensor Source	0 0mA, 1 Pitch, 2 Roll, 3 Temp. 4 485 D1, 5 485 D2
30036 Serial Number		40113 DAC 2 Sensor Source	0 0mA, 1 Pitch, 2 Roll, 3 Temp. 4 485 D1, 5 485 D2
30037 Software Version		40114 DAC1 4mA Setting	
30038 Hardware Version		40115 DAC1 12mA Setting	
30039 Main Thread Heartbeat		40116 DAC1 20mA Setting	
30040 DAC Thread Heartbeat		40117 DAC2 4mA Setting	
30041 ADC Thread Heartbeat		40118 DAC2 12mA Setting	
30042 Comms Thread Heartbeat		40119 DAC2 20mA Setting	
		40200 Unlock Code 1	A55A
30050 Raw Pitch(F/B) f		40201 Unlock Code 2	5AA5
30052 Raw Roll(L/R) f		40202 Unlock Code 3	AAAA
		40203 Pitch Cal Number of Samples	
		40204 Pitch Cal S1 Actual	
		40205 Pitch Cal S1 Expected	
		....	....
		40300 Unlock Code 1	A55A
		40301 Unlock Code 2	5AA5
		40302 Unlock Code 3	BBBB
		40303 Roll Cal Number of Samples	
		40304 Roll Cal S1 Actual	
		40305 Roll Cal S1 Expected	
		....	....

### 3 Connections

Fischer 9-Pin Connector

(Part number S105A101-130 + cable clamp E31 105.2/9.2+ B)

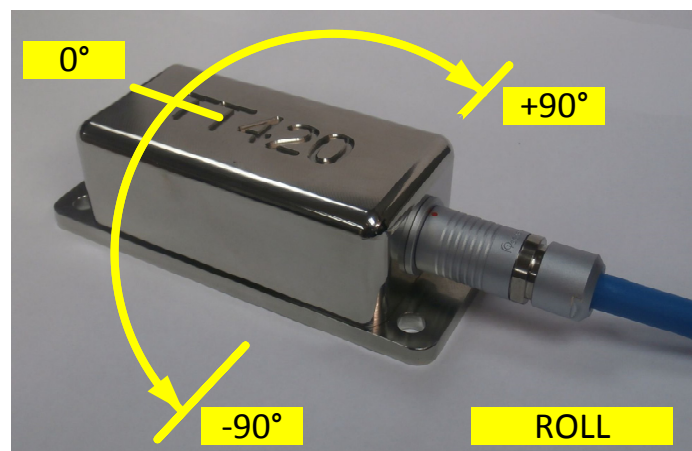
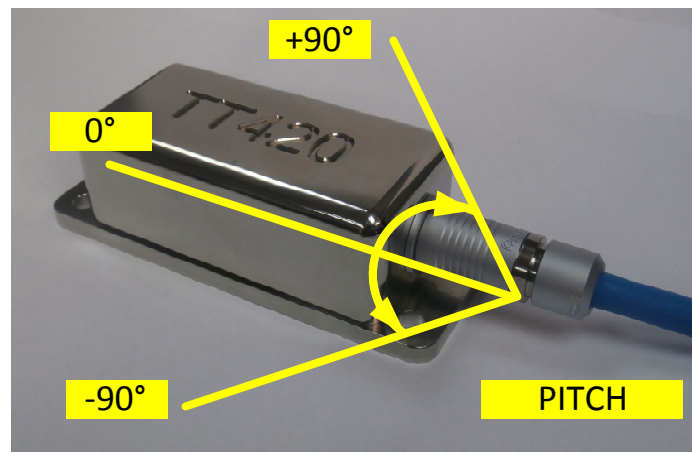
Core		Fischer	Function
Colour	Pair	Pin	
Black	5a	1	0V SUPPLY I/P
Blue	4a		
Violet	5b	2	12V SUPPLY I/P
Red	4b		
Green	2a	3	0V SIGNAL COMMON
Yellow	2b	4	4-20mA O/P #1 (PITCH)
White	1a	5	0V SIGNAL COMMON
Brown	1b	6	4-20mA O/P #2 (ROLL)
Braid		7	0V (cable screen)
Grey	3a	8	RS485 - B
Pink	3b	9	RS485 - A

**Note: The cable core colours are shown for reference if using a CSL supplied cable assembly utilising Lutze 117320 cable.**

## 4 Installation

- The connections to the units 9-Pin Fischer connector, as shown above, should be made using good quality cable having  $\geq 0.5\text{mm}$  insulation thickness between cores. Alternatively a ready-made cable assembly can be purchased - shown on the front page picture.
- The operating parameters must not exceed those detailed on the certificate.
- This apparatus must only be installed or replaced by a competent person who must ensure that existing I.S. segregation is maintained.
- The operators should be trained in the safe use of the equipment, such that operational hazards arising from misuse are avoided.

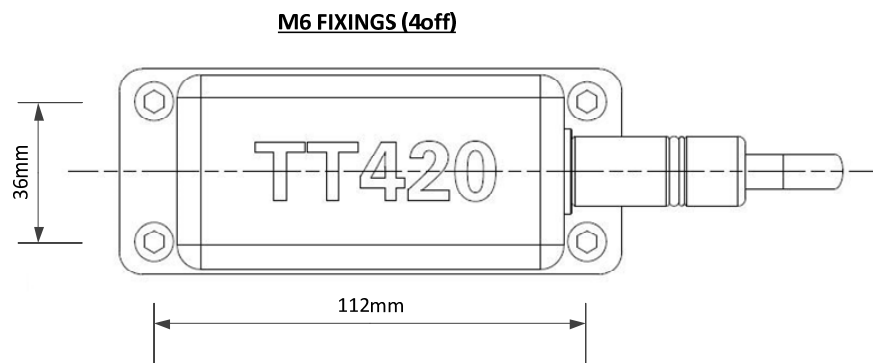
The unit should be mounted observing the following orientation –



## 5 Mechanical Details

All values are approximate.

Length	130mm
Width	53mm
Depth	40mm
Weight	1.1Kg.



## 6 Environmental

Operating Temperature	-40°C...+70°C
Storage Temperature	0°C...+40°C
Humidity	0...95% RH, non-condensing
Ingress Protection	IP66

## 7 Conformity

The TT420 Tilt Transducer is designed and manufactured to be compliant with the following Standards and Directives:

- EN 60079-0:2012, IEC 60079-0:2011 Ed 6  
Electrical apparatus For explosive gas atmospheres:  
General requirements
- EN 60079-11:2012, IEC 60079-11:2011 Ed 6  
Explosive atmospheres:  
Intrinsic safety “i”  
  
EN 60079-26:2006  
Explosive atmospheres:  
Equipment protection level (EPL) Ga
- 89/336/EEC                      EMC Directive
- 73/23/EEC                        Low Voltage Directive

## 8 Maintenance

No routine maintenance is required. Any damage that may affect the safe operation of the unit, e.g. - damaged enclosure, connector or cable, should be corrected by replacing the unit or cable, there are no user serviceable parts inside and to maintain dust seals the units should not be disassembled by the end user. Note: The complete assembly is encapsulated.

## 9 Certification

Ex ia I Ma, Category M1

Ex ia IIB T4 Ga

Ex ia IIIC T135°C Da

CML 13ATEX2011

IECEX CML 14.\*\*\*\* (*pending*)

See certificates for further information.